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Fundamentalism Against the Patchwork Theory of Laws

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Abstract

This paper offers an analysis of the arguments between fundamentalists and the claims made by Nancy Cartwright in *The Dappled World*. I start by introducing the arguments of fundamentalists through the work of Carl Hoefer, and go on to discuss Cartwright's patchwork theory of laws, which is opposed to fundamentalism. Cartwright argues that the fundamentalists cannot claim that laws can be generalized, while the fundamentalists insist that they can make such claims. I will argue that this conflict between both sides places each side in the same epistemological boat. Once we recognize that both views are in the same boat, it is easier to distinguish which view is better, instead of attempting to prove that one view is superior to the other outright. I will argue that fundamentalism has the upper had in this debate, because this view allows for both theoretical and practical advances to be made in science and technology, while Cartwright's view only advances the practical applications of current science. Cartwright's arguments against fundamentalism will also be shown to ask too much of Hoefer and the fundamentalists, specifically with her **F=ma** example. Finally, I will show that fundamentalism can accomplish everything Cartwright's patchwork theory can and more.

Philosopher Nancy Cartwright opposes the scientific view of fundamentalism in her book *The Dappled World* by arguing that fundamentalists cannot have a unified theory, because there will never be enough information to prove all of their laws. She contends, instead, that science can only ever consist of a patchwork of laws that work in specific circumstances. Cartwright argues that her patchwork of laws are better for solving practical problems, while fundamentalists research for research's sake. In what follows, I use philosopher Carl Hoefer's paper "For Fundamentalism" to explicate the fundamentalist's position and argue for its theoretical and practical applications. It will be shown that both sides want to use their findings to better practical fields such as medicine and technology, but the methodology of each side differs in its approach. Cartwright is interested in applying existing knowledge to solve practical problems, while the fundamentalists continue to research theoretical problems knowing that such advances will lead to practical solutions. I argue that fundamentalism is more valuable than Cartwright's patchwork suggests despite her arguments. In contrast, Cartwright's view only aims to produce solutions to applied scientific problems without the contributing to a unified or theoretical science.

Cartwright's central thesis in *The Dappled World* argues that laws are true in the parts of reality that match our interpretive models, and we cannot argue that our laws are true outside of those models. For philosopher Carl Hoefer, Cartwright's claims sound frighteningly similar to this claim: "We have reason to think that the laws of a physical theory hold only in those cases where we can show that they hold."[1] This sounds less like a critique of how fundamentalists use projections, rather Cartwright implies that such projections should be heavily limited or removed from our scientific methods. Fundamentalists believe that the range of approximate truth of the Schrödinger equation goes further than the cases for which it is explicitly stated. For them, this practice of broadening the truth is a reasonable projective claim based on the successes of quantum mechanics. Putting Hoefer's views aside, the fundamentalists do project too much, but they should be allowed to project, so that their findings can be applied in novel ways outside of the laboratory. When the fundamentalist is allowed to project outside of the lab, then theoretical science can influence the creation of practical solutions to real world problems. Quantum mechanics is a good example of this.

The discovery of quantum mechanics did not provide direct solutions to practical problems. Rather it provided a better picture of how atoms work. This improved scientific picture allowed engineers and researchers to create devices and medicines to improve the lives of human beings for the foreseeable future. Theoretical and practical needs were met with the discovery of quantum physics. This is the benefit of the fundamentalist point of view: if one makes scientific discoveries for the sake of research, those results can be applied to practical problems. Cartwright undervalues the importance of theoretical research contributing to practical solutions for real world problems. The fundamentalist view focuses on theoretical advances, but those theoretical advances have led to countless practical solutions and innovations in medicine and technology. One must understand why fundamentalism is a potentially attractive view if it is to be shown that it has value.

In the paper "For Fundamentalism" Hoefer offers his reasoning for being a fundamentalist. The fundamentalist argument for quantum mechanics as a possible fundamental theory of science was not convincing to Hoefer before he worked through the exact solution of Schrödinger's equation for the hydrogen atom.[2] Hoefer says that quantum mechanics offers a differential equation for the hydrogen atom, which states that mathematical laws can describe the structure of matter. When working through the

[1] Carl Hoefer, "For Fundamentalism," *Philosophy of Science* 70(5): 1401–1412, p. 1408. http://dx.doi.org/10.1086/377417

[2] Carl Hoefer, "For Fundamentalism," p. 1404

exact solution for the hydrogen atom, one discovers that in some important way, on Hoefer's view, that the solution must be correct. The hydrogen atom can have a stable state with this equation, because "the proton and electron are bound to each other spatially yet never collapse as one would classically expect."[3] For Hoefer, these results are realistic and exact, rather than approximate and idealized as Cartwright would say. For Cartwright, the fundamentalists are unable to have realistic or exact results, because they are unable to definitively prove the generality of laws and experiments.[4] Let's take the model of the hydrogen atom as an example of this.

The hydrogen solution comes solely from an equation and nothing else, and this, to Hoefer, is the most fascinating aspect of the solution.[5] So when quantum mechanics is replaced by a more comprehensive theory of the universe, that new theory should include the mathematical explanation of the hydrogen atom. Hoefer can see how the mathematical equation might be seen as non-fundamental some day, but the description of hydrogen will need to be derivable from another mathematical law or laws.[6] The mathematical equation for the hydrogen solution appears to be, and will continue to be, fact on Hoefer's view. This example will be the beginning of the usefulness that fundamentalism offers. The hydrogen solution is highly theoretical, but in having a better theoretical picture of subatomic particles allows engineers to create new technology based on those theoretical findings. For instance, the better understanding that quantum mechanics gives of the atom opened the door for engineers to build transistors, which were used to make smaller computers, and eventually developed into cell phones and other technologies that we use everyday. When scientists have a better knowledge of atoms they can design better technologies based on the theoretical information. The fundamentalist is fulfilling the practical needs of society while exploring the theoretical curiosity of science. This is the first step to understanding fundamentalism and its value.

Hoefer's example gives us a good point of reference for the views of fundamentalists. He believes that the smallest particles can be explained mathematically and accurately, and thus that the world and its phenomena can be described through these descriptions as well. These findings will most likely endure more scientific revolutions and will continue to affect the way we think about the universe and the objects we create in it. The model of the atom has been refined over several centuries, but the 20th and 21st centuries have vastly expanded our knowledge at the sub-atomic level. This

[3] Carl Hoefer, "For Fundamentalism," p. 1404

[4] Nancy Cartwright, *The Dappled World* p. 34

[5] Carl Hoefer, "For Fundamentalism," p. 1404

[6] Carl Hoefer, "For Fundamentalism," p. 1404

advancement in our knowledge has brought about fields such as nanotechnology, which does not operate at the sub-atomic level but is on the micro scale. Advancements in fields such as nanotechnology have provided innovative solutions to medical techniques and treatments. These practical solutions would not have been possible without the theoretical advancements made by theories like QM. Scientists are also very confident that atoms and their subatomic particles exist due to the massive amounts of evidence discovered over the past century. Any credible future scientific revolution would, most likely, include the existence of atomic particles, rather than ridding them altogether.[7] Yet Cartwright objects to the claims that a unified science wants to make, and challenges widely accepted equations like **F=ma**.

Cartwright's main argument against fundamentalism concerns an example about the equation **F=ma** and its descriptive power of falling objects. **F=ma** says that if we know the mass of an object and multiply it by its acceleration, then we can know the force of the object and, in some cases, its trajectory. Cartwright views the equation as having to predict where the rock will fall, in addition to what the force of the rock will be. This view of the equation is a misconstrued one, and her example falters because she argues that **F=ma** should describe more than it does. The example she gives states that we can predict where a rock will fall when it is dropped from a balcony using **F=ma**, but there is no accurate prediction for dropping a dollar bill in the same situation, because wind and other forces affects its course. When a rock is dropped from a balcony, forces such as wind affect the location of where the rock will land also, but the effect of the wind is oftentimes negligible and the prediction is still considered accurate. The fundamentalists would argue that **F=ma** gives an accurate description of both scenarios, but that Cartwright demands too much from the equation.

Cartwright wants to describe the **F=ma** example as a *ceteris paribus* law. *Ceteris paribus* states that a law or experiment only works under a particular set of conditions. Cartwright would like to claim that **F=ma** should be a *ceteris paribus* law, or that it will only work when there are no other forces like wind. This seems problematic considering what has already been said. The only conditions **F=ma** needs are an object and a force to exert on the object, and both the dollar bill and the rock fulfill these criterion. Cartwright wants to say that the equation should be even more particular than this, and that forces such as the wind should be taken into account as well.[8] But accounting for the wind would be describing the example she gives with something other than **F=ma**. The guidelines she uses to mark out her argument are unclear.

[7] Carl Hoefer, "For Fundamentalism," p. 1403

[8] Nancy Cartwright, *The Dappled World* p. 27

No guidelines have been given for what laws such as **F=ma** are responsible for describing. Clearly the same forces are affecting both the dollar bill and the rock, but these forces affect each object differently. Forces that are not included in **F=ma** affect both objects, such as wind, but these effects are not apparent on the final location of the rock. **F=ma** plays the same role in both the rock and the dollar bill example, because the equation only describes the downward force of each object and not the other forces affecting the experiment. The dollar is still vulnerable to the forces of gravity and wind, but we do not need a model that describes the wind in order to understand that **F=ma** is describing the falling motion of the dollar bill, and not necessarily where it lands.

With this example Cartwright argues that fundamentalism is not able to model such situations, and is therefore inadequate as a theory. For her, our theories and laws only work within particular conditions. She does not hold the view that equations like **F=ma** can be applied everywhere at all times. Cartwright's argues that science cannot have a fundamental concept of itself, and if we attempt to hold this position we are misleading ourselves. The example of the dollar bill, for Cartwright, is an example of an inaccurate picture of our reality, and if scientists want to create an accurate image of the universe, they should recognize the fault of our assumptions about our theories and laws. Cartwright offers a patchwork theory of laws as a replacement for fundamentalism, and she believes that her theory recognizes that our laws and experiments only work in particular circumstances. These particular circumstances are the only place our laws will work; they almost always fail in the observable 'real' world.

Cartwright's view is not true for the fundamental laws she argues against. **F=ma** is an applicable description of an object, even if other forces alter its course, because the equation is describing the behavior of the object falling and not the other forces affecting the experiment. Many contemporary experiments are expected to predict and describe results within the particular parameters of the experiment, but **F=ma** is not responsible for the description of the wind affecting the falling dollar bill. Rather **F=ma** tells us that the dollar *will* fall to the ground, but not necessarily *where*. The point is clearer if a heavy storm surrounds the balcony while both objects are dropped. The equation **F=ma** still applies to the rock, even if the storm blows it to another point on the ground, similar to the dollar bill example. **F=ma** only needs to tell us that the rock will fall. No description of the wind is necessary for the equation to hold true.
Cartwright's claim is centered on the issue of projection in contemporary science.

Cartwright's development of *ceteris paribus* laws leads to her claim about projections in contemporary science. On her view, our laws are not universal, especially our most fundamental laws about what are taken to be fundamental particles. The belief that experiments work outside of the laboratory is not a projection Cartwright is willing to accept, even if such phenomena exist. On Cartwright's view, scientists create and produce the results that they want within the laboratory, and should not be allowed to make any projections from their results about the world, because there is no proof these experiments work outside of the laboratory.[9] Hoefer gives a defense for the fundamentalists against Cartwright's arguments.

Hoefer offers a curious defense in response to Cartwright's critiques of fundamentalism using her **F=ma** argument. As we have seen, the **F=ma** example shows that the second law of physics is not universal because we cannot explain or model the outside forces into our account of the dollar bill dropping from a balcony. For Hoefer and other fundamentalists this example does not falsify Newton's second law. Fundamentalists believe, on faith, that if one back-calculates the **F=ma** example and takes into account gravity and the forces affecting the dollar, then the forces calculated really did exist.[10] In addition, these forces "are in principal derivable from other fundamental physical laws."[11] But Cartwright is unwilling to accept the faith of the fundamentalists, so she argues that the dollar being dropped does not fall under **F=ma**'s *ceteris paribus* law, because particular circumstances are not satisfied. Cartwright's objection is reasonable. Why would we take things on faith in science? We would not, and this is a weakness in Hoefer's argument, but it's also possible that Cartwright and Hoefer do not fully understand each other. Hoefer does not seem to think we need a model of the wind in order to understand that **F=ma** applies to the example, and we should not need one if we understand what **F=ma** describes. Hoefer's use of the word faith does not help his case. Instead, he should argue for the limitations of the descriptive power of **F=ma**, rather than discussing back-calculation, something he cannot fully defend. Cartwright implies that the equation should give a full explanation of the situation. For our purposes we need to understand that **F=ma** does describe falling objects, but does not give an entire description of what will happen when the object falls, nor does it need to.

Cartwright does not demand that a fundamental theory give a model for the dollar dropping, but she does demand that if one has faith in fundamental laws they should be able to describe how a model could be constructed. Fundamental laws are unable to fulfill Cartwright's demands, but they do have a set of interpretive models that "demonstrably obey the relevant laws."[12] Cartwright is unsatisfied with the amount of evidence that fundamentalists give for their theories, while Hoefer and the fundamentalists are content with their findings. Both sides spread themselves too thin with their arguments and attempt to argue separate points when they are actually leaning towards a similar conclusion. Practical applications are necessary for both sides, but Cartwright wants to focus on practicality exclusively, while the

[9] Nancy Cartwright, *The Dappled World* p. 28

[10] Carl Hoefer, "For Fundamentalism," p. 1406

[11] Carl Hoefer, "For Fundamentalism," p. 1406

[12] Carl Hoefer, "For Fundamentalism," p. 1407

fundamentalist gives room for both theoretical and practical science. But Cartwright also wants the fundamentalists to limit their projective power, despite the advances that have been made with these projections.

Cartwright's central thesis in *The Dappled World* argues that laws are true in the parts of reality that match our interpretive models, and we cannot argue that our laws are true outside of those models. For Hoefer, Cartwright's claims sound frighteningly similar to this claim: "We have reason to think that the laws of a physical theory hold only in those cases where we can show that they hold."[13] This sounds less like a critique of how fundamentalists use projections, rather Cartwright implies that such projections should be heavily limited or removed from our scientific methods. Fundamentalists believe that the range of approximate truth of the Schrödinger equation goes further than the cases for which it is explicitly stated. For them, this practice of broadening the truth is a reasonable projective claim based on the successes of quantum mechanics. Perhaps the fundamentalists do project too much, but they should be allowed to project, so that their findings can be applied in novel ways outside of the laboratory. When the fundamentalist is allowed to project outside of the lab, then theoretical science can influence the creation of practical machines. The fundamentalist's ability to do theoretical research and apply findings to practical machines gives fundamentalism the upper hand over Cartwright's views.

Hoefer suggests that Cartwright's arguments saddle the fundamentalist with unreasonable reductionist demands. These reductionist demands do not need to be discussed fully; rather the limitations that Cartwright and the fundamentalists have placed on themselves should be recognized. Cartwright wants to say that the fundamentalists cannot definitively say that hydrogen atoms in the real world look the same as the ones in the laboratory. The fundamentalists believe that they can project such claims from their findings. Neither is in a position to prove their findings absolutely correct, so we must decide which view provides the better results for science and society. This attitude seems to discourage new mathematical descriptions of the universe from turning into actual experiments that can yield evidence for the claims the mathematics make. Two of Cartwright's main claims intersect at this point: her view that science should focus on practicality and her desire to limit the fundamentalist's ability to project.

In limiting the fundamentalist's use of projection, Cartwright lowers the value of the theoretical work being done by fundamentalists. She advocates a scientific position that favors the use of science as a conduit through which practical machines can be built to aid society. The parameters and uses of Cartwright's theories are well known to her. There is no question in her mind that her system works, but they limit the possibility of our theories applying and assisting society outside of the laboratory.

[13] Carl Hoefer, "For Fundamentalism," p. 1408

The hydrogen solution gives us an exact and realistic description of the hydrogen atom. This theoretical discovery and others like it have allowed scientists to take steps forward in theoretical physics and the practical applications of their findings, despite the fundamentalist's inability to prove that hydrogen atoms are homogenous throughout the universe.

Cartwright is unable to definitively prove that a patchwork theory of laws is more valuable than working towards a unified theory of laws. One can see that the fundamentalist view is valuable despite Cartwright's arguments against it, in its theoretical and practical advances. Cartwright heavily advocates the creation and research of practical solutions to be made for the benefit of mankind. This is a great cause to advocate for, but it sounds like Cartwright's views would be building new machines out of older ones, because of her lack of interest with theoretical science. One must ask if we would move forward, and if so at what rate, to create better machines for the benefit of mankind if we did not do theoretical research. Quantum mechanics allowed scientists to develop new technologies for the benefit of mankind at a rapid pace, but theoretical advancements in the field of physics needed to happen before such benefits could be had. Fundamentalism is the better view because of this reason. Scientists are capable of doing research in theoretical fields that will eventually contribute to our engineers in their laboratories. There is no telling how the findings at CERN will benefit the engineer working to better medical technologies, but based on the history of science such theoretical advances will almost certainly improve our practical applications of our scientific knowledge.